STROMBERG

Concrete Fence-Posts

Civil Engineering

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CONCRETE FENCE-POSTS

BY

JULIAN WILLIS STROMBERG

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

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This is to certify that the thesis prepared under the immediate direction of Instructor L. A. Waterbury by

JULIAN WILLIS STROMBERG

entitled CONCRETE FENCE POSTS

is approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

Ira O Baker

Head of Department of Civil Engineering

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Introduction.

The field of application of cement has become widely extended in recent years, due to the increase in the price of lumber and the decrease in the cost of cement, and also to the improvement in the quality of cement. Railroads and farms require an enormus number of posts each year. Owing to the decrease in the supply and quality of cedar posts, some investigations have already been made to determine the merits of concrete as a substitute for wood for use in posts. The manufacture of concrete posts has already become an important industry, although many posts are being made without regard to scientific

principles. It is the purpose of this thesis to describe a series of tests on concrete posts made by the writer and to discuss methods of construction and materials used in the manufacture of such posts.

General Discussion of Concrete Posts.

The essential requirements for a satisfactory post are reasonable cost, durability and sufficient strength to withstand ordinary usage.

Cost The cost of a concrete fence post will depend upon the locality in which it is made. For a post made on a farm containing a gravel pit, the cost of the materials should not exceed 16 cents. When sand, gravel or stone and labor are to be paid for, the cost of a post will vary from 20 to 40 cents each. A cubic yard of concrete will make 34 posts each 7'-0" long and having a cross section of 16 square

inches. This will require 1.16 barrels of cement. If the price of cement is 50 cents a bag, the cost of the cement in one post will be 7 cents. Reinforcement varies greatly in its cost, but the usual range is from 5 to 10 cents, the average being about 7 cents. Two men should be able to make 100 posts per day. With men earning $1.50 per day, the cost of labor for one post will be 3 cents. Sand and gravel at $1.00 per cubic yard will cost 6 cents per post. Under these conditions the cost of one reinforced concrete post would be:

Cement	7	cents
Reinforcement	7	"
Sand	3	"
Gravel	3	"
Labor	3	"
Fasteners	2	"
Total	25	cents.

Durability One of the most desirable properties of concrete is its durability. Concrete is not injured by fire, frost or water and is not subject to decay, so that the life of a concrete post may safely be assumed to be 40 years. A wooden post will last from 5 to 9 years, so that during the life of one concrete post about 5 cedar posts would be required.

The cost of resetting one post is about 5 cents and the price of cedar posts is from 15 to 16 cents. There-fore, during a period of 40 years an expenditure of $1.00 would be required for wooden posts as com-pared with 30 cents for the concrete post. The future changes in the cost of materials and labor which occur will probably make concrete posts still more economical as compared with wooden posts.
Another point which may be mentioned is that ordinarily the fence wire will will outlast wooden posts, and therefore by using more durable posts

the maximum service can be obtained from the wire.

Strength. In cases where a fence is used merely as a dividing line the strength is of minor importance and a small, neat post will suffice. A post which is likely to receive shocks or which must withstand considerable stress, as a corner post, should have a large area, and the reinforcement should be sufficient in amount to take all the tensile strains. It is well known that wooden posts are stronger than is necessary. Economy demands that the cement posts be made as small as possible.

The actual loads which will come upon a fence post cannot be determined. Concrete cannot withstand a very great jar and it is better to replace a broken post than to make all posts excessively heavy.

Reinforcement should be used not only to save concrete, but to make the post small and neat, so it can be handled and shipped. The reason for this is that concrete is high in compressive strength, but has little or no tensile strength. To fully reinforce the concrete, the steel should be 1 to 1½ per cent of the cross sectional area of the post and should be placed as near the surface

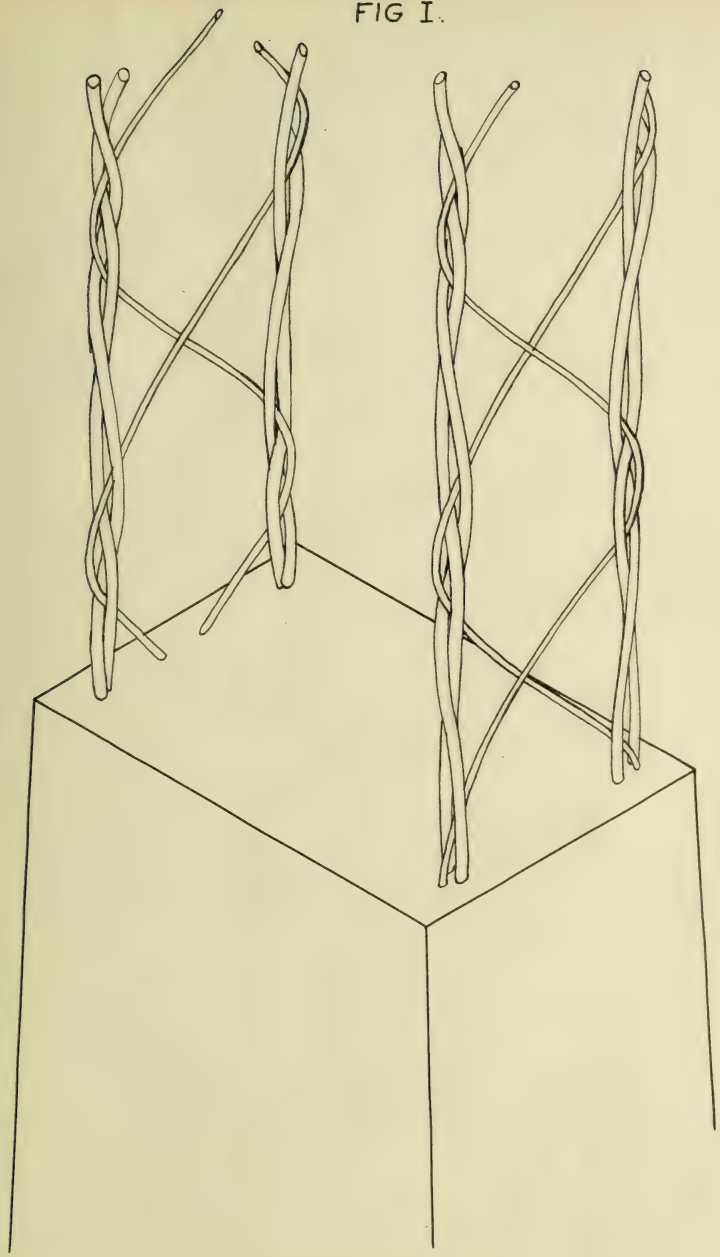
as possible. Steel with a high elastic limit is best for this purpose. The side from which the greatest force is expected, as the face towards the inside of the field, should have more reinforcement than the other faces.

Barbed wire is a good reinforcement, but it is extremely difficult to handle. Plain, twisted and woven wire; various iron and steel rods and bars; pipe; perforated and expanded metal plate; and combinations of each have been used. Some of these are shown in fig VII. Fig. I shows the way the Truss and Cable woven wire was used in the posts tested. This reinforcement is

efficient because it has a high elastic limit and does not slip in the concrete.

The size of the post should be governed by the use for which it is intended. A tapering post saves material and has its maximum strength at the point where the greatest force acts. A small post as shown in fig VII is sufficiently strong for an ordinary fence.

FIG I.



Concrete. The concrete should be made of Portland cement, clean, sharp sand and broken stone or gravel under ½ inch. It has been found that the best mixture for this purpose is 1:2½:5. A dry mixture makes a better looking post, but is not so strong, needs more tamping and does not fill the moulds as well as a wet mixture. Gravel is nearly as strong as the crushed stone and is so abundant in most districts that it is generally used. The tamping should be thorough and should follow each successive layer of concrete as it is added.

Moulds. There are many kinds of moulds upon the market. Those who have had experience in post making claim that wooden gang moulds are the best. These are easily constructed of boards the length of the post, by placing them so as to form groves in which the posts are moulded. Fig. X shows a mould of this kind having two faces of the post tapering. The mould shown in Fig. IX has four tapering faces. The wood should be shellacked to prevent swelling due to moisture and to avoid the sticking of the cement. Fig. VIII shows the mould used in

making the hollow post whose cross section is shown in fig. III.

Posts should not be removed from the moulds for at least 3 or 4 days after they are made. They should be covered with sand to prevent the direct sun's rays from drying them too rapidly and should be sprinkled with water occasionally for about a week. They should never be used until they are at least 60 days old.

Fasteners. Of the many methods which have been devised for fastening the fence wire to the post, few are satisfactory because it is difficult to secure a fastener that is both simple

and durable. Holes in the post were at one time used, but this is a poor way to fasten the wire because it weakens the post. Post No. 1 of Fig. XI shows a strip of wood wired to the post. This nailing board is sometimes bolted to the post by means of bolts imbeded in the concrete. Post No. 2 has the fence wire held to it with a small rod held in place by bands around the post. Post No. 3 shows the same method, and also two forms of holding the fence wire to the post with a wire twisted around the post. This method is often used in case of repairs. The method illustrated by post No. 4 is more expensive

than the other forms shown. It consists of an iron bar with holes in it for the fence wires to pass through. Post No. 5 shows the wires fastened by staples imbeded in the concrete and bent over. These staples should be of the shape shown in Fig XV to prevent their pulling from the post.

The American Concrete Co. of Detroit, Michigan, have a patented post with a nailing strip of metal mesh work along the face. It is claimed that the metal serves as a reinforcement and also to hold staples driven into it. Owing to the brittleness of concrete it is not advisable to use a hammer on it as

with a wooden post. It is also open to the objection that the holes made in the post by the staple will hold water and thus cause disintegration during freezing weather.

A cement post company in Wisconsin uses a strip of treated wood partly imbedded in the concrete to serve for a reinforcement and a nailing strip. If the wood is at all affected by water it will expand and split the post. The reinforcing effect of a strip of wood is of little value.

The patented fasteners are of many designs, most of which are too complicated. Two of the best ones are shown

in Fig. XIII and XIV. A simple fastener that will hold the wire to the post firmly and is not subject to decay is shown in Fig XII. This is recommended by Mr. Philip L. Wormeley, Jr., in Farmers Bulletin No. 235 of the U.S. Department of Agriculture. It is a galvanized iron staple imbeded in the concrete with a loop protruding. The fence wire is fastened by a small piece of twisted wire.

FIG. II.

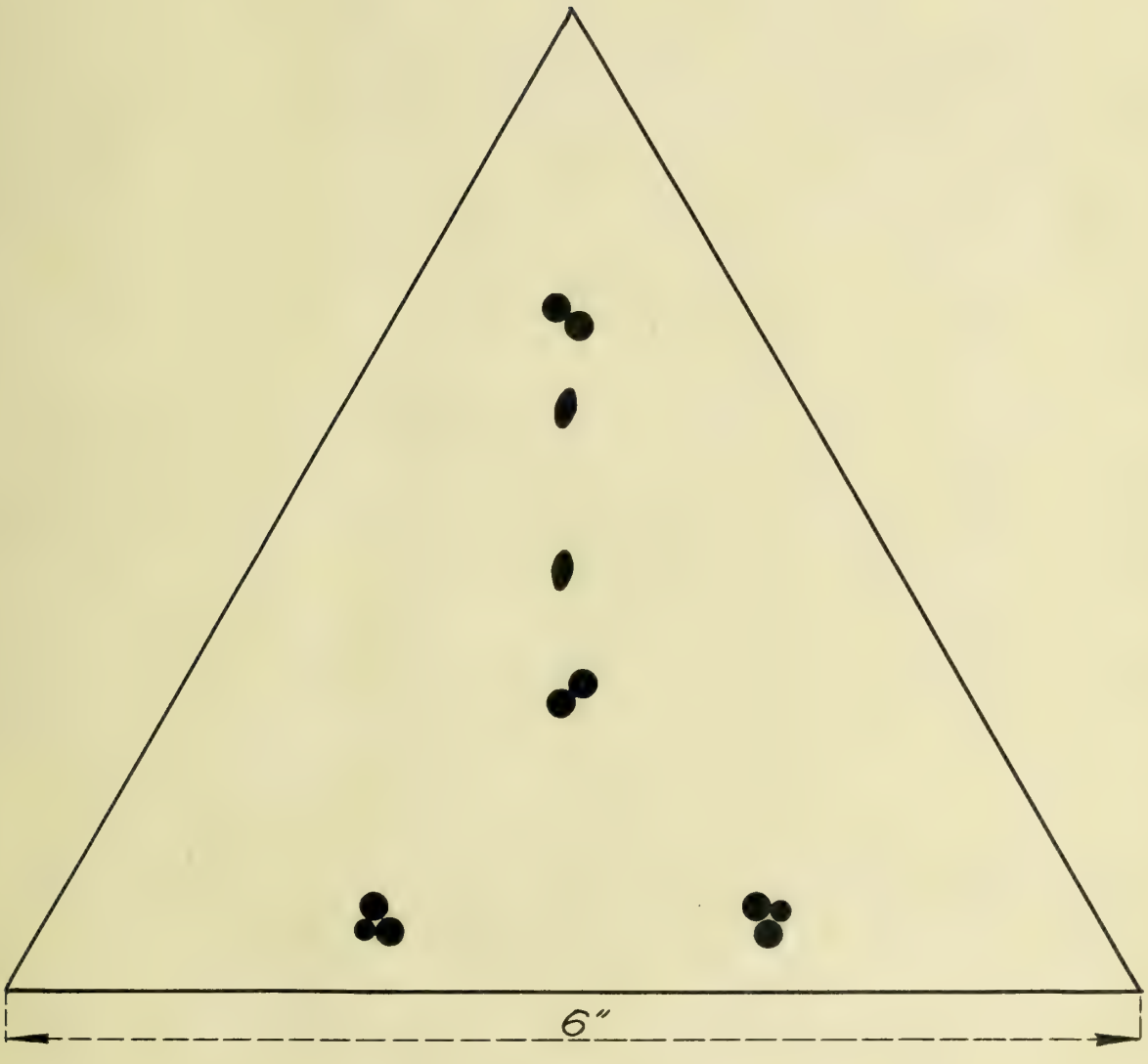


FIG. III.

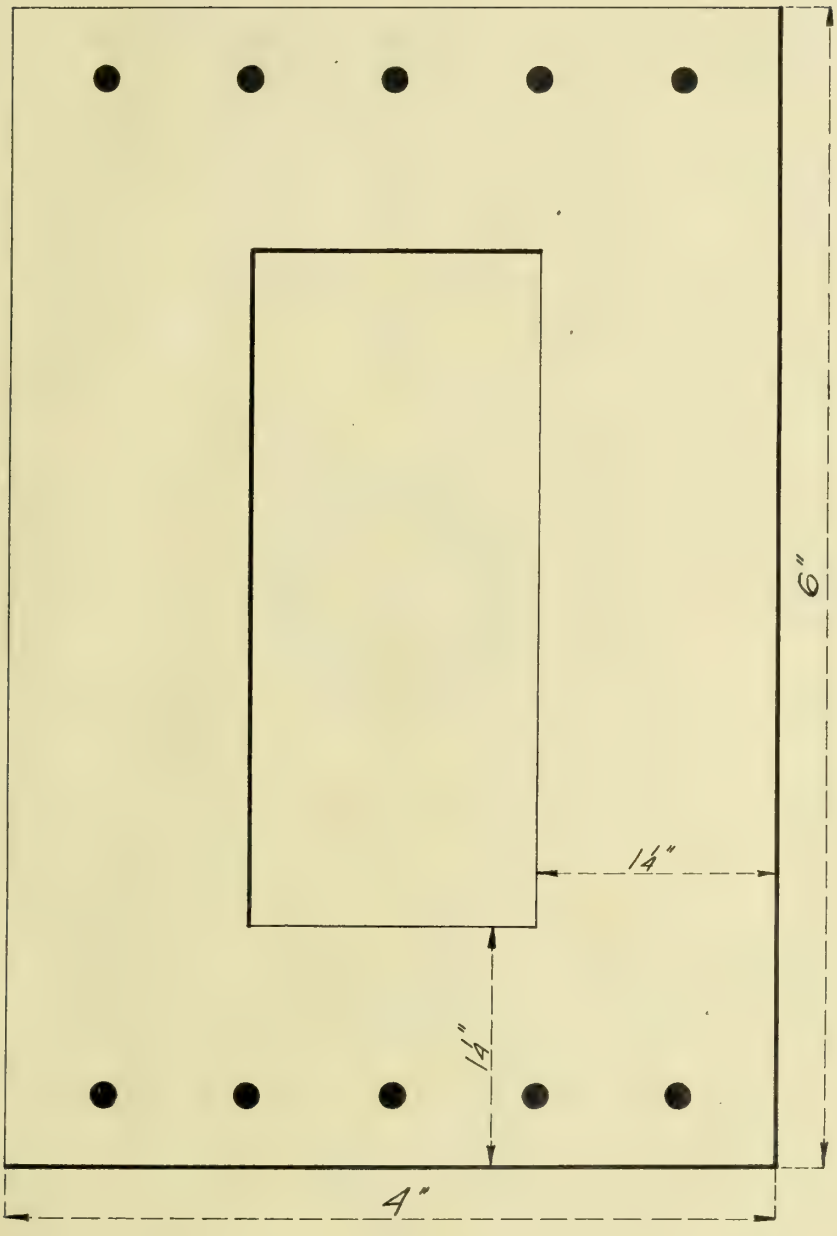


FIG. IV.

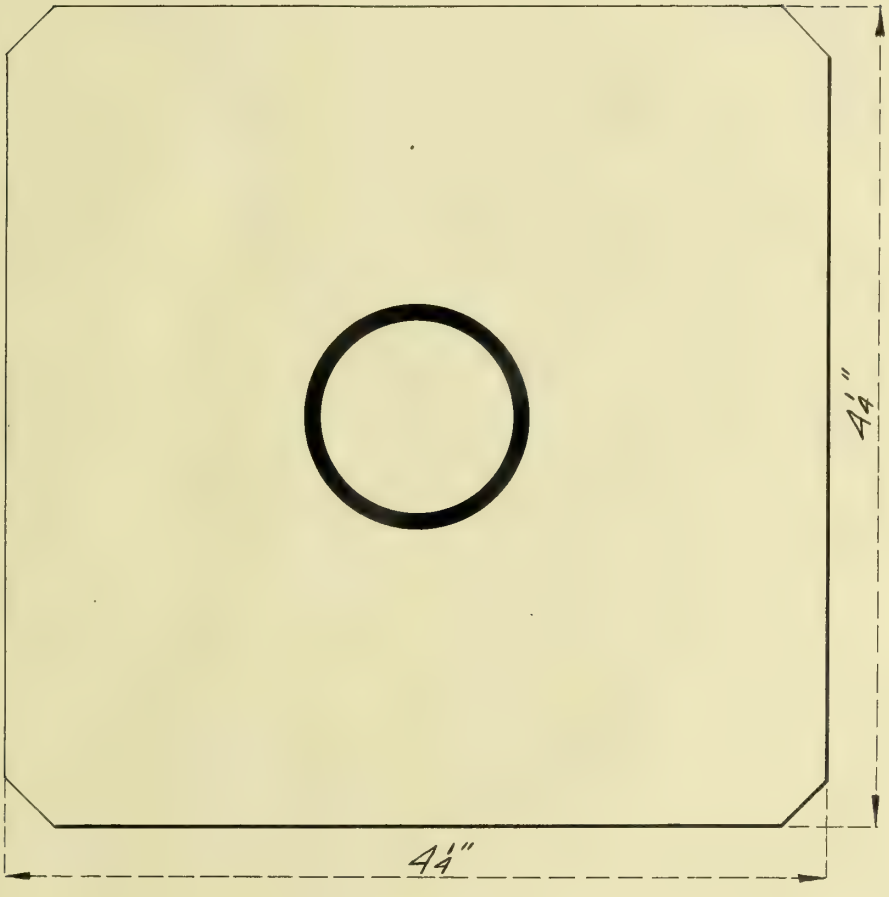


FIG. V.

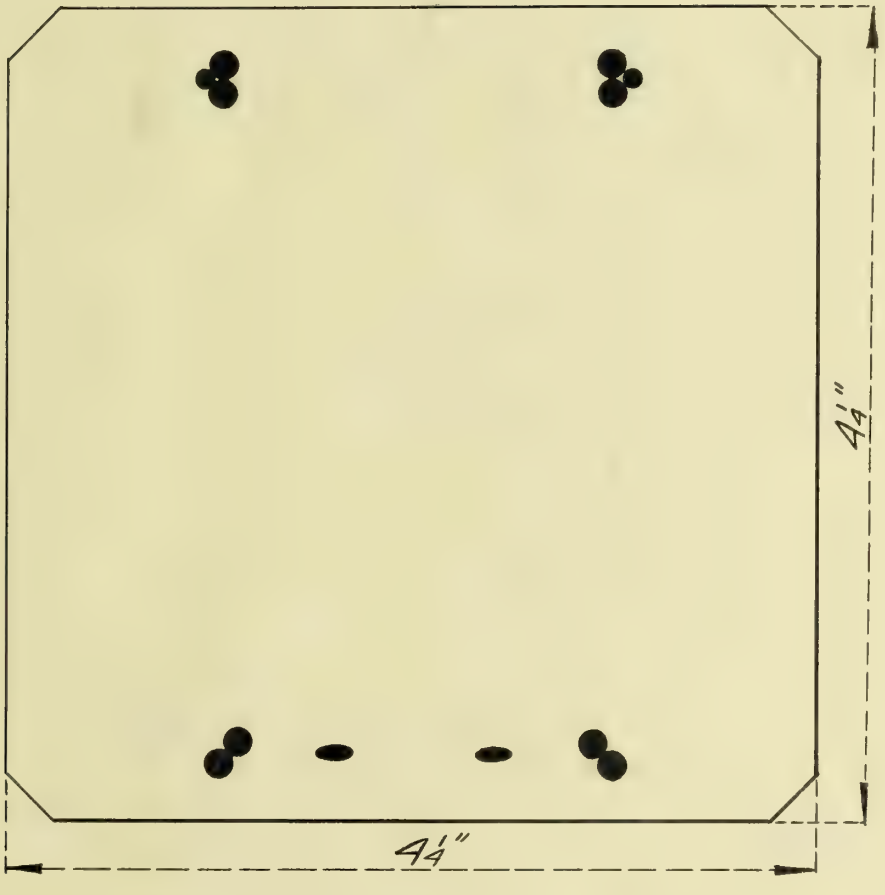


FIG. VI.

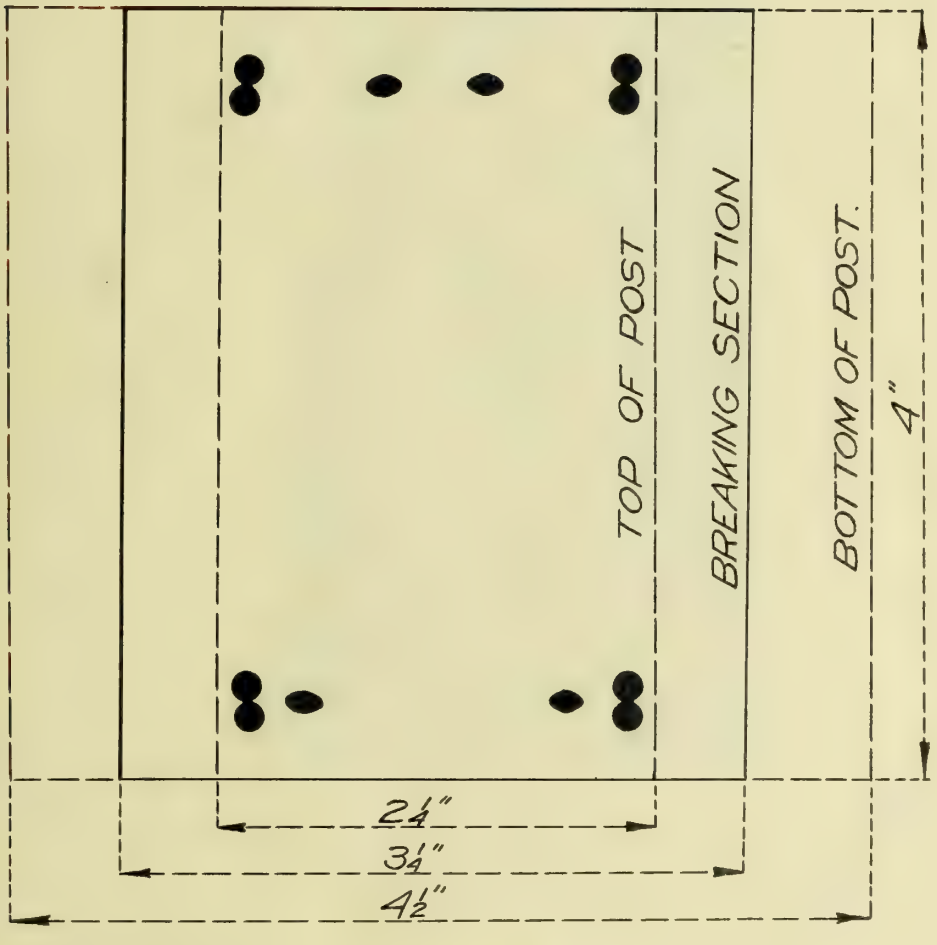


FIG. VII.

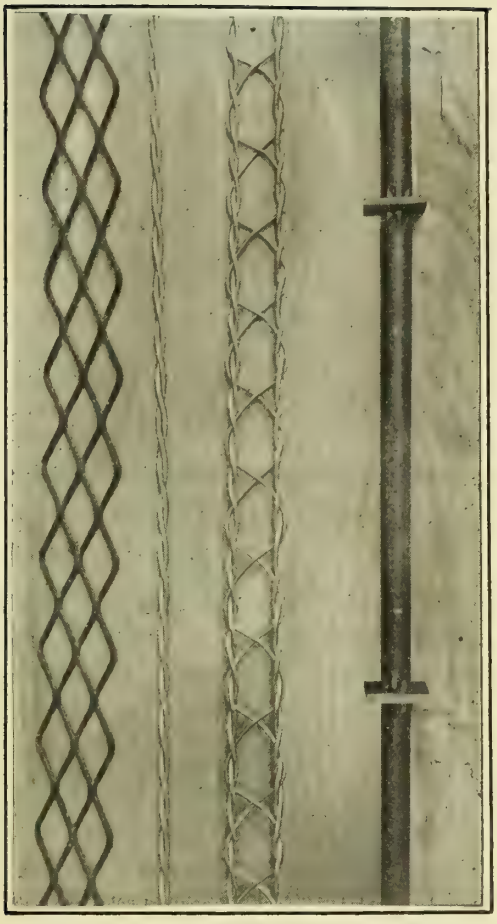
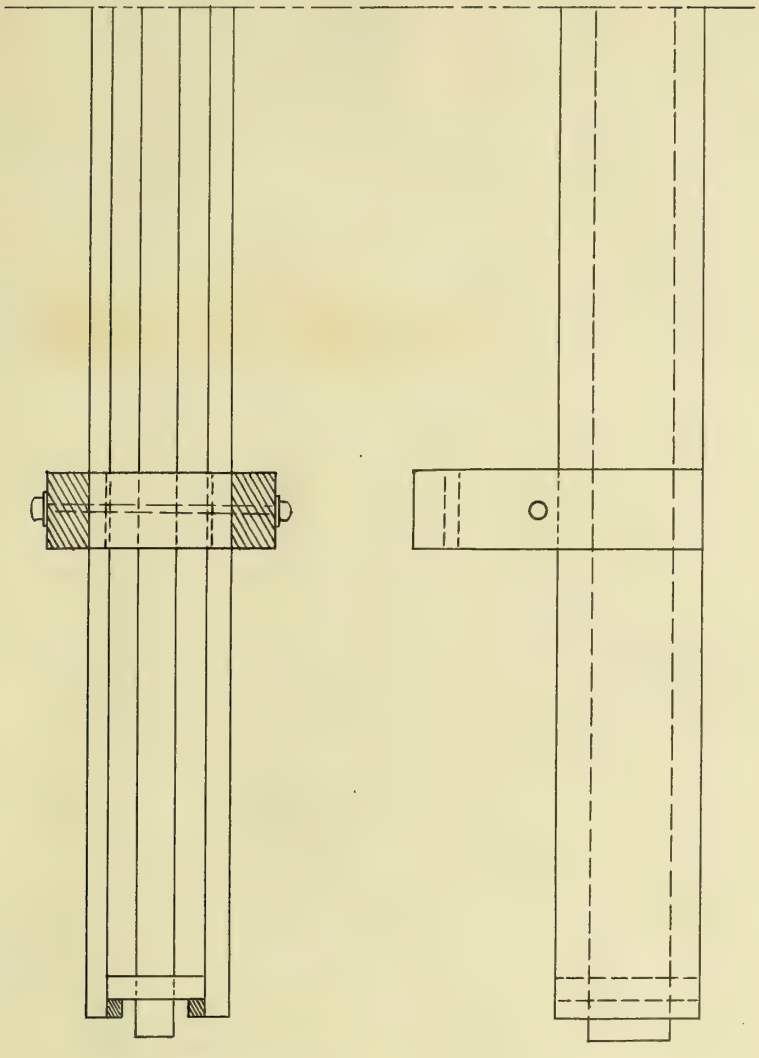


FIG. VIII.



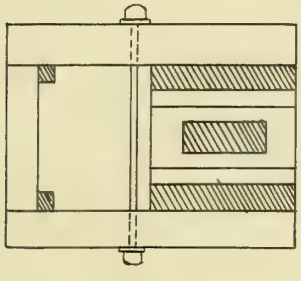


FIG. IX.

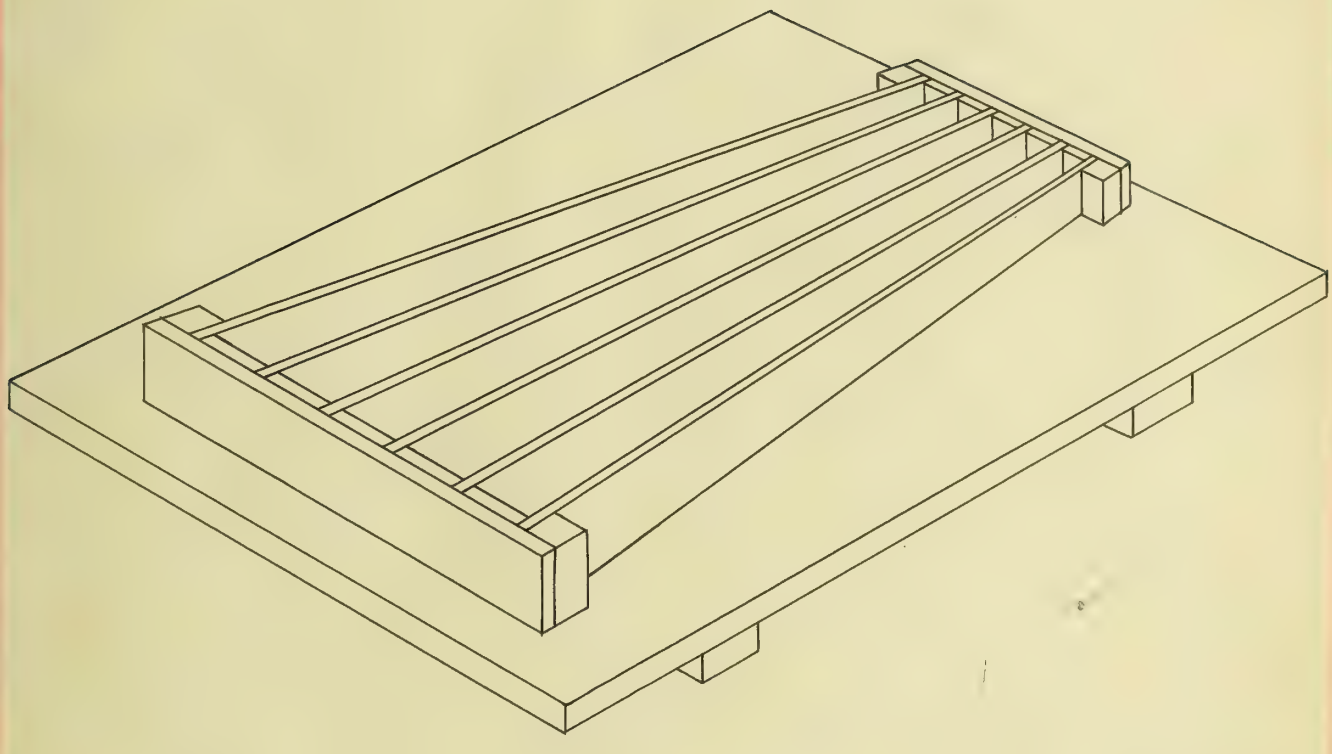


FIG. X.

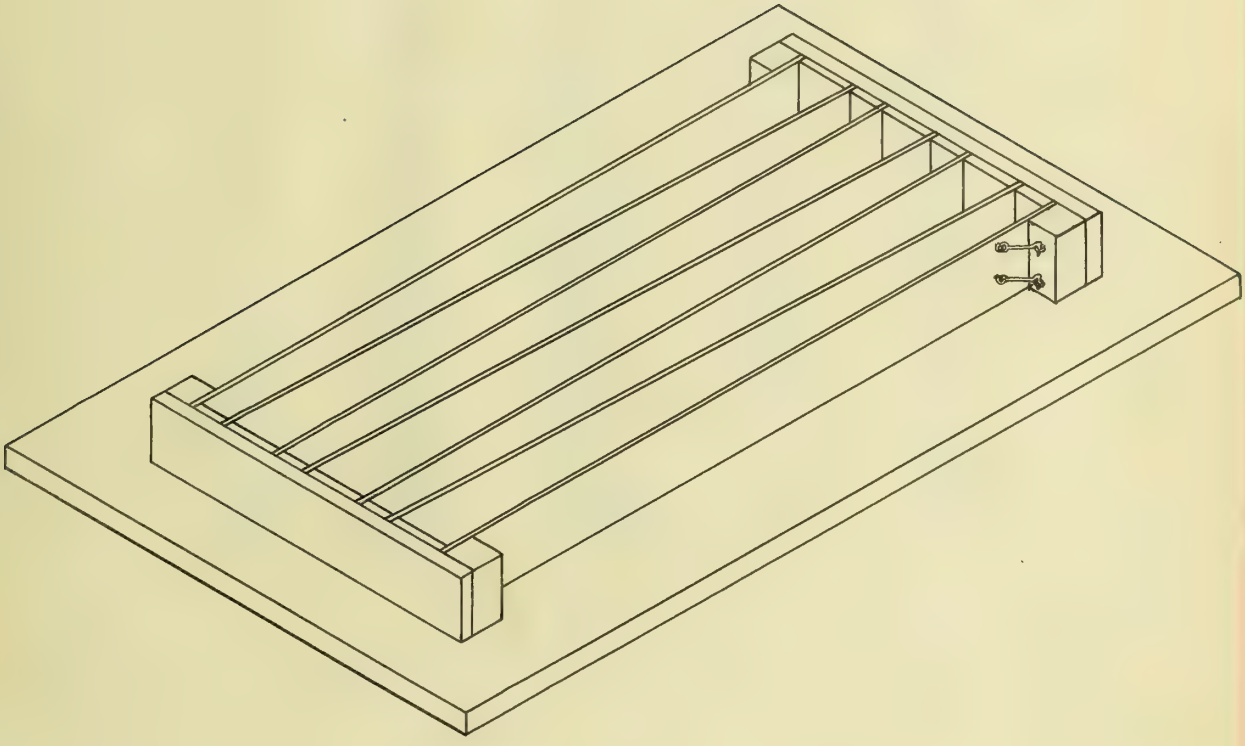
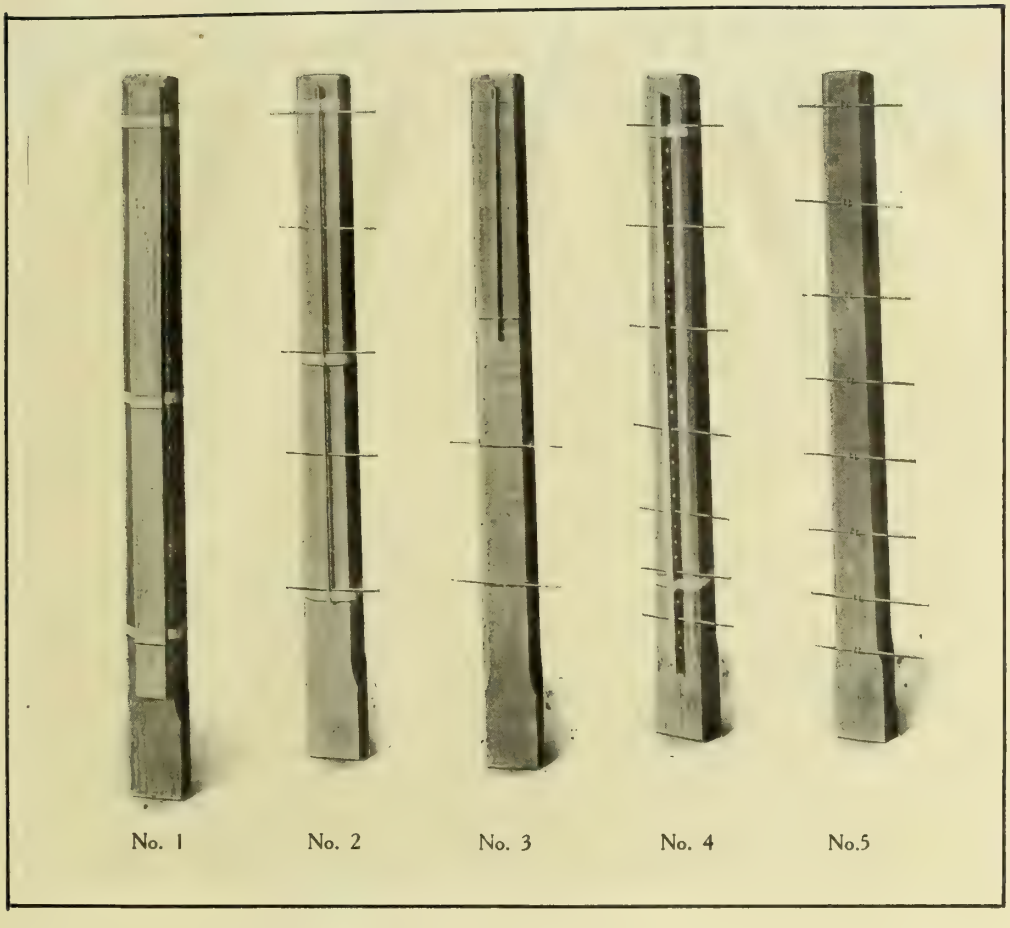


FIG. XI.



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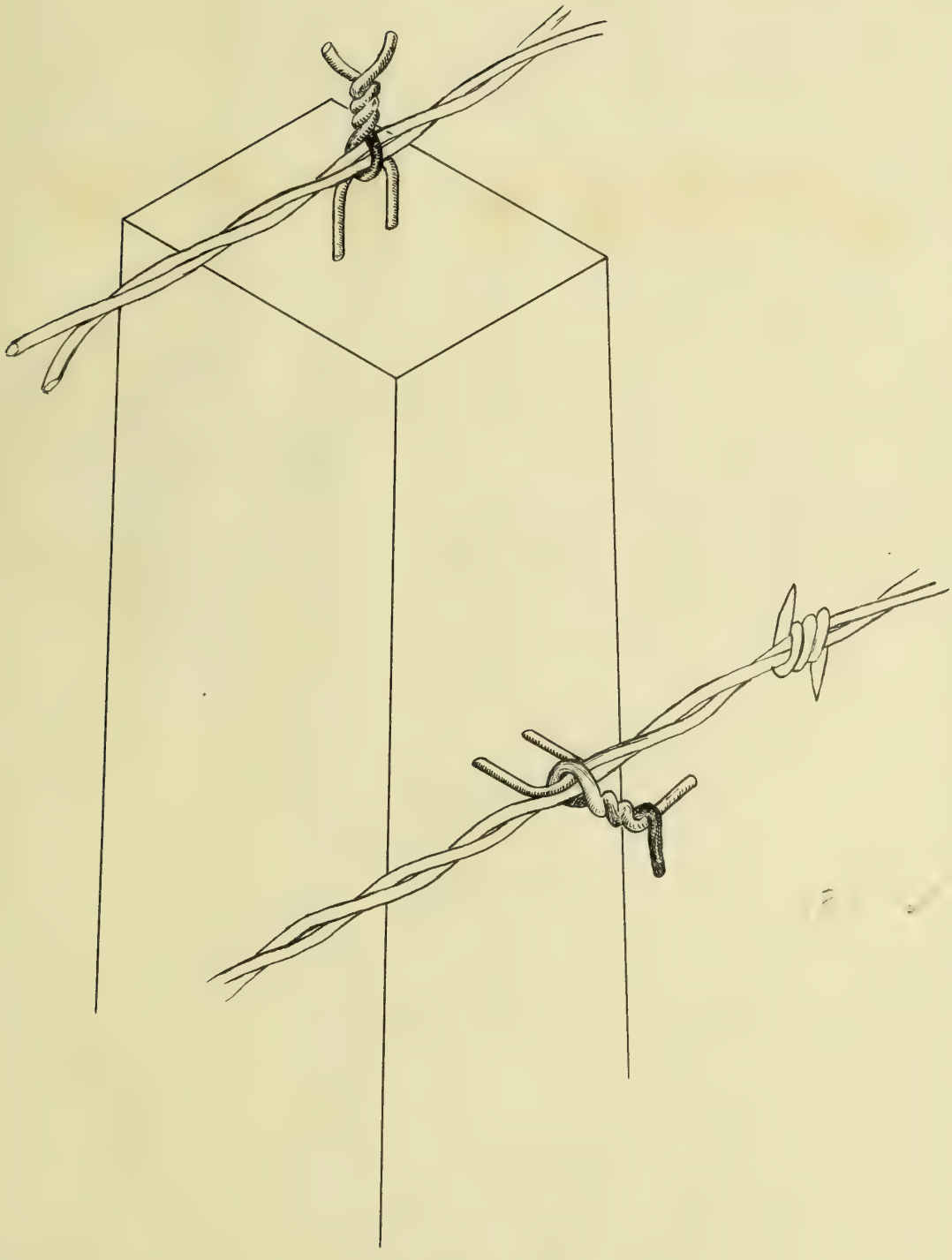

FIG. XIII.

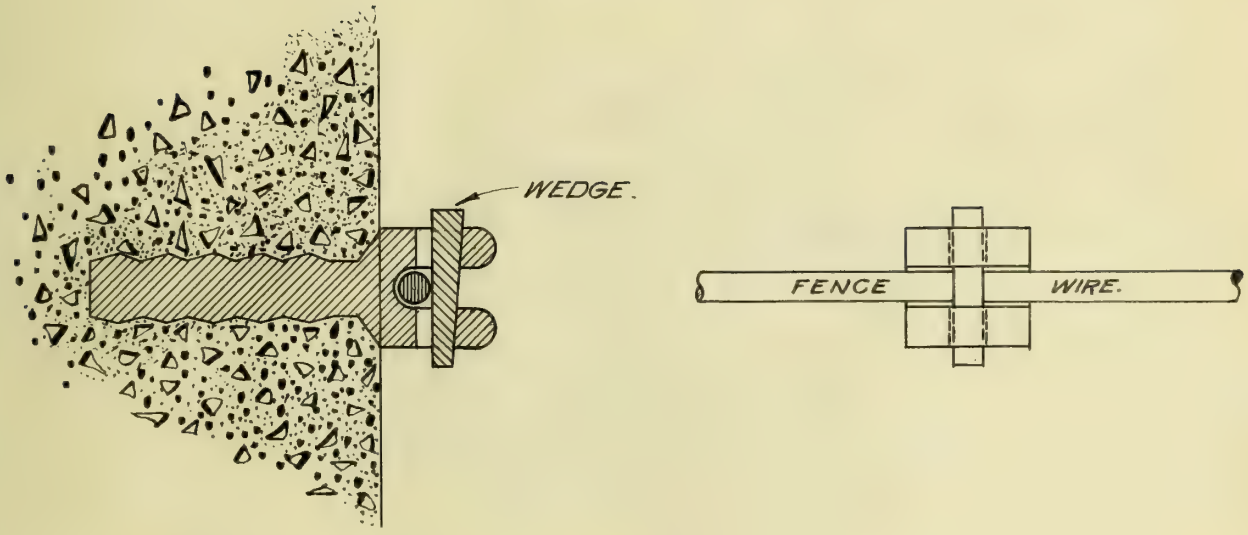

FIG. XIV.

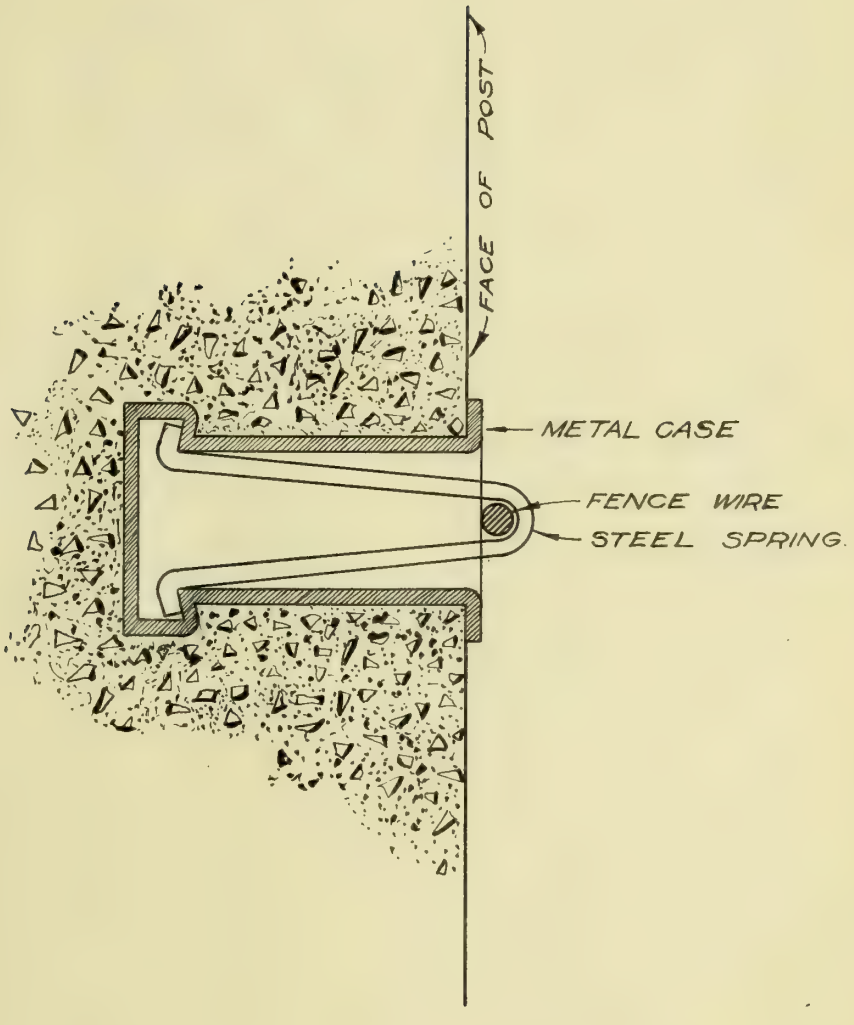

FIG. XV.

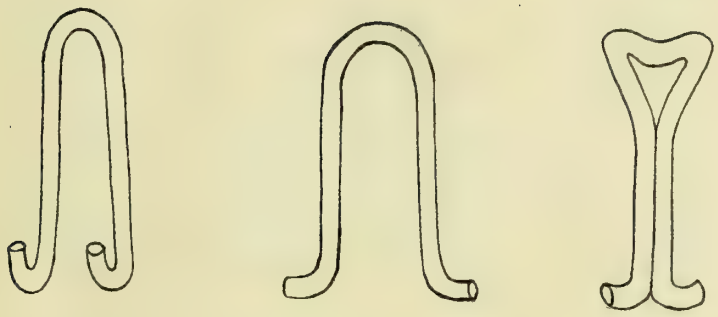

TABLE SHOWING STRENGTH OF CONCRETE POSTS.

POST NUMBER	SECTION SHOWN IN FIGURE NUMBER	AREA OF BREAKING SECTION SQ. INS.	MATERIAL AGGREGATE	MIXTURE	PER CENT OF REIN-FORCEMENT.	MAX. LOAD IN POUNDS 6'-0" BETWEEN SUPPORTS
1	III	18.7	STONE	1:2:4	.46	0
2	IV	18	DO.	DO.	2.76	0
3	V	16	GRAVEL	DO.	1.08	960
4	V	16	DO.	DO.	.71	750
5	II	15.6	STONE	DO.	.73	870
6	—	18	GRAVEL	DO.	.93	530
7	VI	13	STONE	1:3:6	1.28	680
8	—	24	DO.	DO	0	0
9	VI	13	GRAVEL	1:2:4	1.28	560

Tests Made by the Writer.

Nine posts were made and were tested at the end of 60 days. The tests were made with the Olson testing machine, in the Laboratory of Applied Mechanics, University of Illinois. A concentrated load was applied at the centre of the beam, the distance between supports being 6 feet. All of the posts were 7 feet in length.

Post No. 1 was reinforced with 10 No. 12 steel wires. In post number 2 a 1-inch gas pipe was used. Post No. 8 had no reinforcement. The other posts were reinforced with woven wire furnished by the Truss and Cable Fence Co. of Cleveland, Ohio. This wire is

POST IN TESTING MACHINE.

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made of high carbon steel and is very efficient for reinforcing concrete. It seems to be free from slipping when stressed in the concrete.

Posts No. 3 and No 4 were alike, except that the first had 0.37 per cent more metal in it than the latter. Post No. 3 sheared the concrete along the plane of the reinforcement, while in post No. 4 the wires snapped. Post No. 1 was hollow. It was thought ~~thooght~~ that by making the post in this form the reinforcement would be at a greater distance from the neutral axis and therefore be more effective. This would perhaps be true if the loads were static.

The post was entirely too brittle. It was made in the mould shown in Fig. VIII. The core was wrapped in oiled paper and was withdrawn after the concrete had set. Post No. 2 was reinforced with a 1-inch gas pipe which seemed entirely ineffective. Since only half the metal acts at one time in an ordinary reinforcement, it was thought that by using a pipe in the center of the post, all the metal would act. Large cracks developed on the lower surface and the pipe slipped inward from both ends. No load was recorded. No metal was placed in the large post No. 8. and it broke in several pieces

immediately after the load touched it.

Tests made by Others.

In 1905, Mr. H.R. Sloeum and Mr. J.S. Huntoon broke six 6-inch cedar fence posts and four concrete posts. The posts were tested as beams resting upon supports six feet apart, with the loads applied at the centre. The average ultimate breaking strength of the cedar posts was 6500 pounds, which is 6½ times as strong for static load as post no. 3, the strongest one tested by the writer.

Mr. C.J. Zinthee made some tests of concrete posts at the Iowa State College. Concrete and wooden posts of the same size were broken under like conditions. His results indicate that white

pine posts are 5 times as strong as concrete posts when tested with static loads and that for resistance to impact wooden posts are very much superior to concrete posts.

Conclusion.

All of the above tests would indicate that concrete fence posts are not very strong even when they are properly made. However, since wooden posts are stronger than is necessary, concrete is not as unsuitable for this purpose as it would appear from comparisons with wooden posts, and the writer believes that if concrete posts are properly

made they will have sufficient strength to withstand the forces which will come upon them. Since in all other respects concrete is superior to wood, concrete posts will probably prove to be satisfactory, although since care is needed in handling concrete posts and the freight rates on them are high, the manufacture of them on a large scale is not likely to be profitable.